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Tinnin,
R. O.

RESPONSES OF DWARF MISTLETOE AND HOSTS FOLLOWING THINNING IN IMMATURE STANDS OF DOUGLAS-FIR ON THE MALHEUR NATIONAL FOREST, OREGON

by

Robert O. Tinnin

RESPONSES OF DWARF MISTLETOE AND HOSTS FOLLOWING THINNING IN IMMATURE STANDS OF DOUGLAS-FIR ON THE MALHEUR NATIONAL FOREST, OREGON

FINAL REPORT

Cooperative Agreement 28-C8-445
with the USDA Forest Service, Rocky
Mountain Forest and Range Experiment
Station, Project RM-4501

Robert O. Tinnin

Department of Biology

Portland State University

Portland, Oregon

December, 1988

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EXPERIMENT STATION

FINAL REPORT
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Two primary tasks were completed under this agreement. The first was to reexamine 12 plots established 15 years ago on the Malheur National Forest. They were set up to study the effects of Arceuthobium douglasii on precommercially thinned stands of Douglas fir. The second task was to establish a new study on the Okanogan National Forest to examine the effects of A. douglasii on thinned, relatively small (ca. 3-15 cm) trees. The study looks specifically at smaller (younger?) leave-trees, as compared with the older study, which it augments.

Malheur National Forest:

All 12 plots were reexamined and the following data were collected: diameter at breast height (d.b.h.), top growth, dwarf mistletoe rating (DMR), stereo-pair photographs, and extraneous notes on the condition or appearance of individual trees (e.g., insect damage). These data were evaluated relative to data collected in 1973, 1974, 1977, 1980, 1983, and 1984.

Attached you will find printouts of the analyses completed to date. The analyses were done to look for patterns of interest to management decisions. Table 1 presents a listing of the mean diameters (d.b.h.) within each infection class, according to the class composition of 1988. (Please ignore the number of significant figures in the printout. All means would be more appropriately listed with a single decimal place accuracy.) The means are plotted in Figure 1 and suggest different rates of diameter growth for uninfected or lightly infected trees as compared with heavily infected trees.

On the basis of this observation I subjected the data to regression analysis, even though there are problems with the integrity of the data. (Most problematic are that the trees were not selected by a random process (which in the technical sense makes the data ineligible for any type of statistical analysis), and that the variances are not homogeneous (Table 2) which suggests that parametric statistics should be applied with caution.)

Table 3 (a-g) shows the results of the regression analysis on each of the 7 infection classes. There are differences in both slope and y-intercept among the classes. Of interest to me were the differences in slope. (The differences in y-intercept point out what is already known, heavily infected trees tend to be smaller

than uninfected trees, so the data were not further analyzed for this report.) Each of the resulting regressions is plotted in Figure 2. Again there is a suggestion of a difference between uninfected and lightly infected trees as compared with heavily infected trees. Figure 3 is a similar plot except that the y-intercept has been adjusted to a value of 1 for all groups to better illustrate the differences in slope.

To determine if there was any significant difference among the 7 classes, I ran essentially an analysis of covariance and found that the resulting F was not significant. Given the failings and characteristics of the data mentioned above, this result is of limited use. A far better approach is to use a nonparametric technique. I chose to examine the 1973-88 growth differential by infection class using the Kruskall-Wallis method for multiple comparisons and uneven sample size. Finding a significant difference among my samples, I determined where the difference was using the technique of Dunn[1]. Preliminary evaluation shows the following:

DMR:	0	1	2	3	4	5	6
Sign. Diff.:	a	a	a	a	ab	bc	c

where there are no significant differences between any two DMR's sharing a letter in common. For example, DMR's 5 and 6 are growing at a rate that is significantly different from uninfected trees, whereas DMR's 1 to 4 are not growing at a significantly different rate. (I am not satisfied that the tests are accurate because of a problem with the program I am using, but rather than hold up the report I will send any important corrections at a later date.)

I also examined overall diameter increase relative to the size of the trees at the beginning of the study. The results are presented in Table 4. While there is the expected decline associated with increased DMR, there is no important difference between the groupings relative to original size. Perhaps size classes could be identified where there might be differences, but I was aware of none that made any more sense than the ones I used. If there is a class of particular interest to you because of management concerns, I would be pleased to make the run. A plot of the data appears in Figure 4.

A similar evaluation is presented in Table 5 where I look at growth performance relative to age. While there is something more of a pattern of interest (see Figure 5), it is not distinct enough to

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[1]Zar, Jerrold H. 1984. Biostatistical Analysis. Prentice-Hall, Inc.

warrant further evaluation in my opinion. Again other age classifications may present something of interest, but the resulting changes in sample size within each of the cells of the matrix would make interpretation difficult.

Table 6 is primarily intended to present incremental increases in basal area (BAI) and a ratio that I have called "mean increment ratio" (IR). These are plotted in figures 6 and 7. There are some marked shifts in BAI relative to the level of infection. I have not conducted any further analysis of these data because at best they would confirm what we already know, heavy infection reduces diameter growth. Of interest to me is the marked decline in performance of all trees between 1983 and 1988. There is a greater decline among the lightly infected and uninfected trees than among the heavily infected trees. The decline itself is probably environmentally initiated (e.g., defoliation by spruce budworm and/or drought), but why do the heavily infected trees appear less affected? The differences may well be insignificant but I am still working on an analysis procedure. Again, if I find anything of interest, I will send those results to you at a later date.

My use of IR was an effort at examining growth performance in the sense of answering the question, how well are the trees doing relative to what they already have done? In this sense, only the trees with DMR 5 and 6 seem to be performing poorly. These data will be examined statistically as part of the BAI procedure once I have settled on an appropriate process.

Table 7 is a summary of growth at each of the four major plot locations on the Malheur. These data show differences among the locations irrespective of the level of infection of the trees within the plots. The table is meant for reference use only.

Table 8 is a printout of many of the original data from the study. I thought might be of interest to someone in your group, now or later. The only explanation that may be needed is to note that a few of the DMR readings between 1983-4 and 1988 show a decline. These are not entry errors, but rather differences in interpreting borderline levels of infection between two readings.

As of this writing, I do not have plans to publish the results of this survey. After I have had more time to review the data and finish the analysis, I may change my mind. This is particularly true after I have collected and analyzed the 15-year results from the Okanogan study that was setup in 1974. I plan to accomplish that task in the summer of 1989.

Okanogan National Forest:

Since I am just starting the study on the Okanogan, there is no report to make on that study. I have enclosed a copy of the data collected (Table 9) for your review. Besides the data listed, I also took stereo-pair photographs of each tree selected in the study.

The site itself is about 20 acres in area and was thinned in 1987 in cooperation with the Tonasket Ranger District. The entire study is set up at one location and is based on a sample of 208 trees. The procedure use to identify the trees was designed to provide a sample as close to random as time would allow.

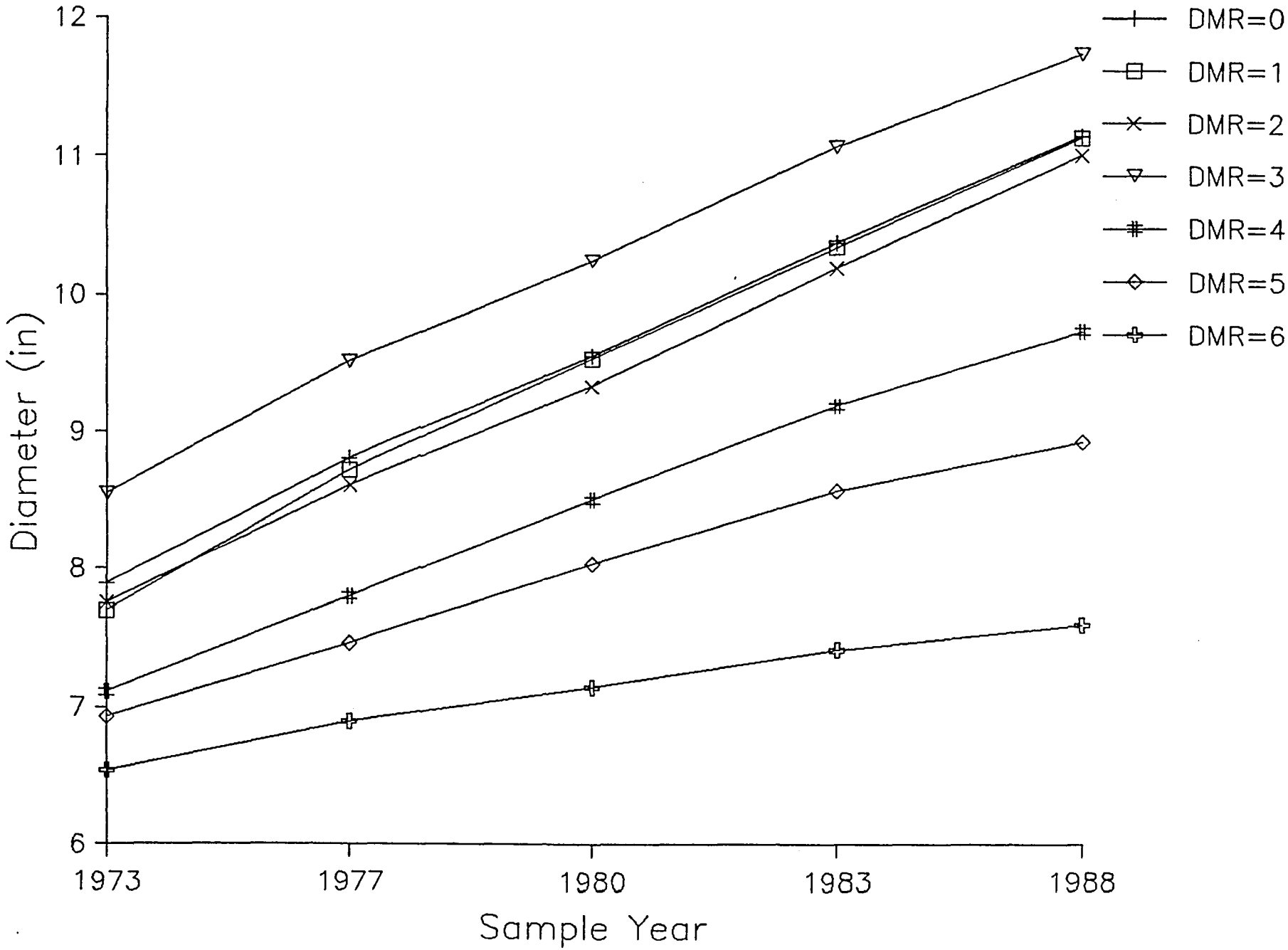
The leave trees tend to occur in small groups. The plot size chosen was 200 m^2 (circular plot with 7.98m radius), so clumps of trees large enough to accommodate a plot of this size were a prerequisite. Within the perimeter of such a clump, three trees not greater than 20 meters from one another were identified as markers. These trees were used to arbitrarily position plot center (i.e., the three trees define a triangle wherein a circle may be inscribed that is tangent to the sides; the visually estimated center of that circle was plot center) with adjustments made to disallow plot overlap. The location of the plot centers was very approximate relative to the true geometric center prescribed, but the point was selected without reference to the trees within the plots themselves, thus without reference to the condition of the trees to be sampled, or their level of infection.

MALHEUR DATA

DMR	n	Mean Diameter (inches) 1973	1977	1980	1983	1988
0	89	7.88652	8.81236	9.55281	10.3697	11.1404
1	48	7.68542	8.72292	9.52917	10.3417	11.125
2	36	7.74722	8.61389	9.33056	10.1917	10.9972
3	50	8.552	9.524	10.24	11.058	11.736
4	27	7.11111	7.7963	8.4963	9.18519	9.73704
5	25	6.928	7.464	8.032	8.572	8.932
6	27	6.54074	6.9037	7.14444	7.41481	7.58889

Table 1

Figure 1


12
11
10
9
8
7
6
Diameter (in)
1973
1977
1980
1983
1988
Sample Year
DMR=0
DMR=1
DMR=2
DMR=3
DMR=4
DMR=5
DMR=6

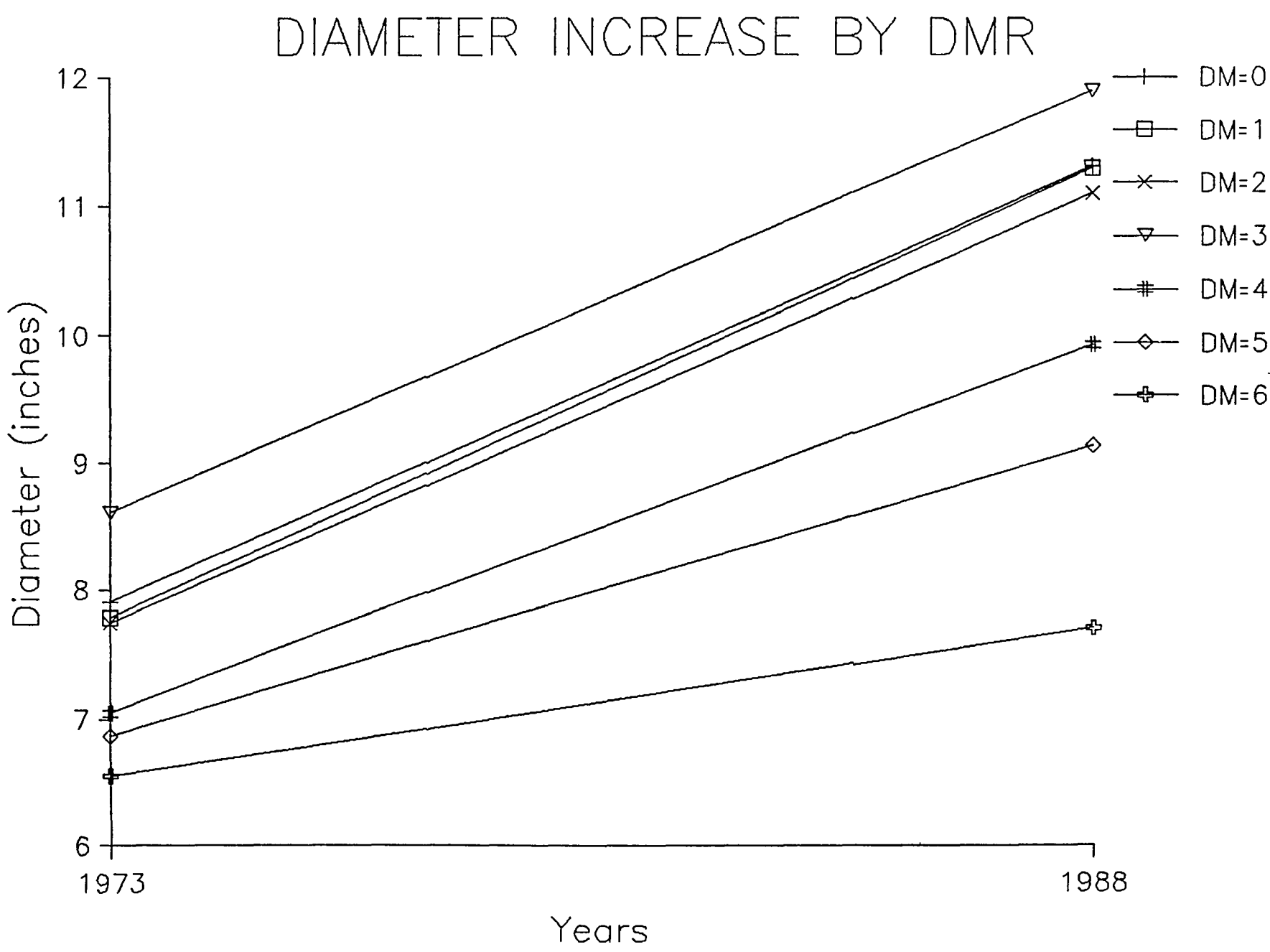
Bartletts test for homogeneity of variance
Diameter, Malheur 1973
Chi square = 22.2626
df = 6

Bartletts test for homogeneity of variance
Diameter, Malheur 1988
Chi square = 25.5058
df = 6

Critical value of Chi square = 12.592

Table 2

Figure 2


DIAMETER INCREASE BY DMR
12
11
10
9
8
7
6
Diameter (inches)
1973
1988
Years
DM=0
DM=1
DM=2
DM=3
DM=4
DM=5
DM=6

Regression for DMR 0
Analysis of the data for c:malhur88.dat

source of variation	df	SS	MS	F
among groups	6	602.1584	100.3597	12.49991
linear regression	1	581.8789	581.8789	143.4645
deviations from regression	5	20.27954	4.055909	0.5051675
within groups	438	3516.632	8.028839	
total	444	4118.79		

The slope (b) is 0.2262923
The y-intercept (a) is -438.5689

Number of samples 445
r-square = 0.1412742

Table 3a

Regression for DMR 1
Analysis of the data for c:malhur88.dat

source of variation	df	SS	MS	F
among groups	6	365.346	60.891	6.84226
linear regression	1	337.3147	337.3147	60.16741
deviations from regression	5	28.03134	5.606269	0.6299707
within groups	233	2073.526	8.899252	
total	239	2438.872		

The slope (b) is 0.2335838
The y-intercept (a) is -453.0803

Number of samples 240
r-square = 0.1383077

Table 3b

Regression for DMR 2
Analysis of the data for c:malhur88.dat

source of variation	df	SS	MS	F
among groups	6	266.7573	44.45956	3.123694
linear regression	1	227.8101	227.8101	29.24597
deviations from regression	5	38.94726	7.789453	0.547281
within groups	173	2462.31	14.23301	
total	179	2729.067		

The slope (b) is 0.223237
The y-intercept (a) is -432.705

Number of samples 180
r-square = 0.08347544

Table 3c

Regression for DMR 3
Analysis of the data for c:malhur88.dat

source of variation	df	SS	MS	F
among groups	6	334.7534	55.79224	5.021421
linear regression	1	301.9177	301.9177	45.97393
deviations from regression	5	32.83575	6.567149	0.5910575
within groups	243	2699.936	11.11085	
total	249	3034.689		

The slope (b) is 0.2186298
The y-intercept (a) is -422.7463

Number of samples 250
r-square = 0.09948883

Table 3d

Regression for DMR 4
Analysis of the data for c:malhur88.dat

source of variation	df	SS	MS	F
among groups	6	154.0374	25.6729	2.016119
linear regression	1	125.2221	125.2221	21.72843
deviations from regression	5	28.81527	5.763053	0.4525785
within groups	128	1629.929	12.73382	
total	134	1783.966		

The slope (b) is 0.1916133
The y-intercept (a) is -371.0072

Number of samples 135
r-square = 0.07019309

Table 3e

Regression for DMR 5
Analysis of the data for c:malhur88.dat

source of variation	df	SS	MS	F
among groups	6	110.2796	18.37993	4.850296
linear regression	1	70.17877	70.17877	8.750295
deviations from regression	5	40.1008	8.02016	2.116447
within groups	118	447.1545	3.789445	
total	124	557.4341		

The slope (b) is 0.1507395
The y-intercept (a) is -290.5425

Number of samples 125
r-square = 0.1258961

Table 3f

Regression for DMR 6
Analysis of the data for c:malhur88.dat

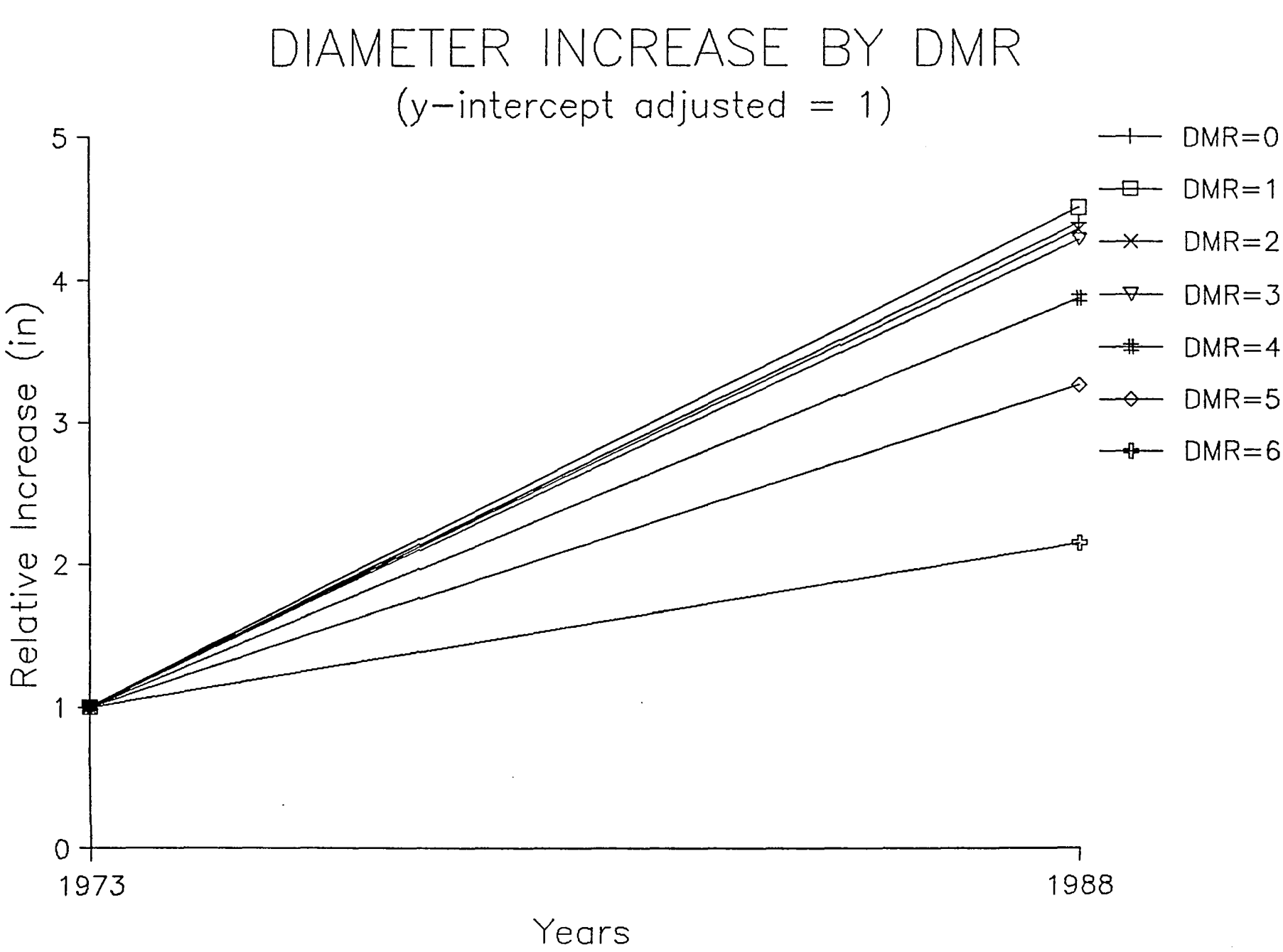
source of variation	df	SS	MS	F
among groups	6	31.71014	5.285023	1.681649
linear regression	1	19.76093	19.76093	8.268723
deviations from regression	5	11.9492	2.389841	0.7604268
within groups	128	402.2736	3.142762	
total	134	433.9837		

The slope (b) is 0.07656858
The y-intercept (a) is -144.5185

Number of samples 135
r-square = 0.04553381

Table 3g

Figure 3

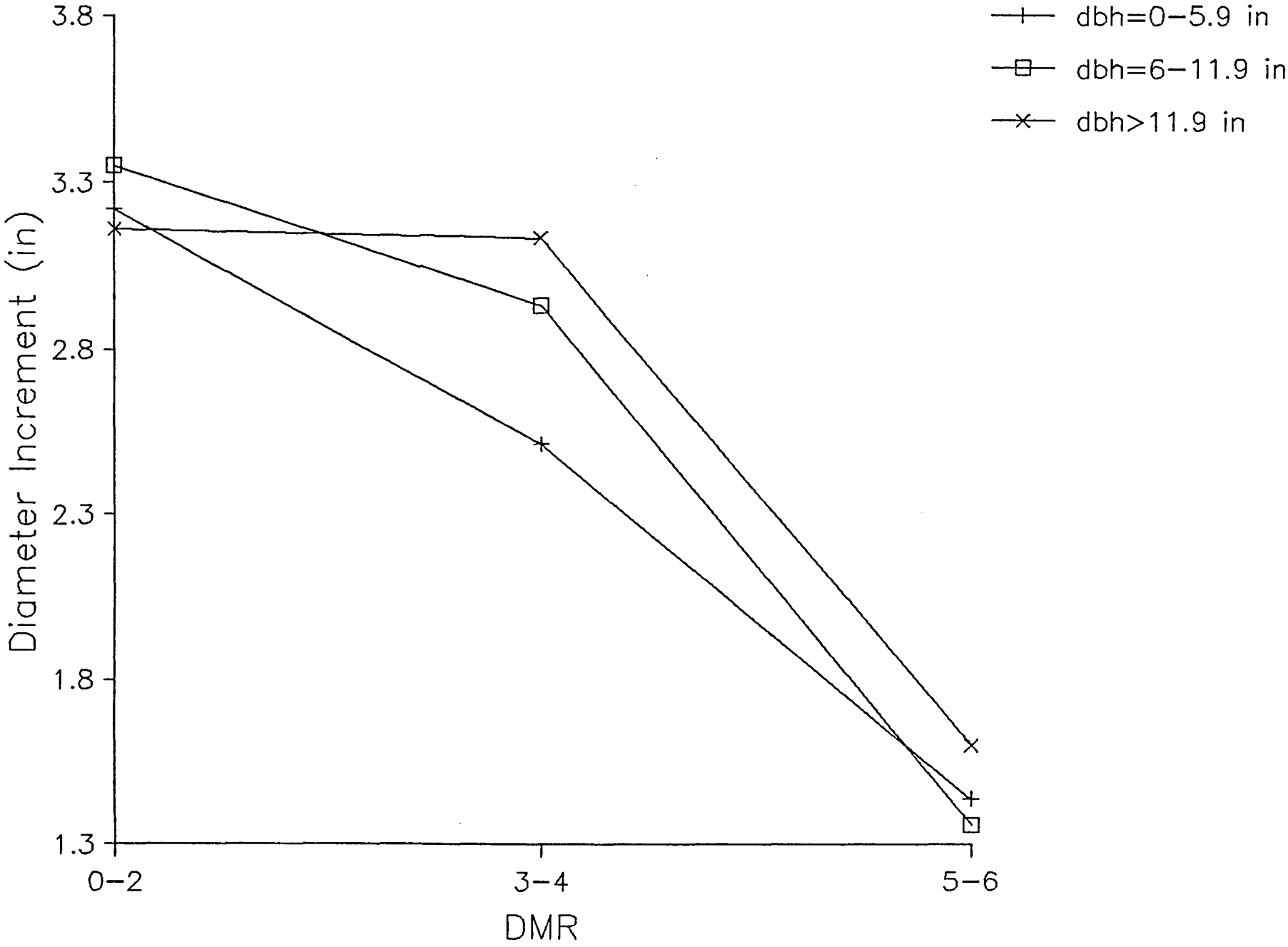

DIAMETER INCREASE BY DMR
(y-intercept adjusted = 1)
Relative Increase (in)
0
1
2
3
4
5
1973
1988
Years
DMR=0
DMR=1
DMR=2
DMR=3
DMR=4
DMR=5
DMR=6

MALHEUR DATA
Mean Diameter Increase (1973-88)

dbh73		DMR 0-2	3-4	5-6
0-5.9 in	+ dia	3.2234	2.51212	1.43529
	n	47	33	17
6-11.9 in	+ dia	3.34532	2.92609	1.356
	n	139	23	25
>12 in	+ dia	3.15714	3.13333	1.6
	n	14	3	1

Table 4

Figure 4

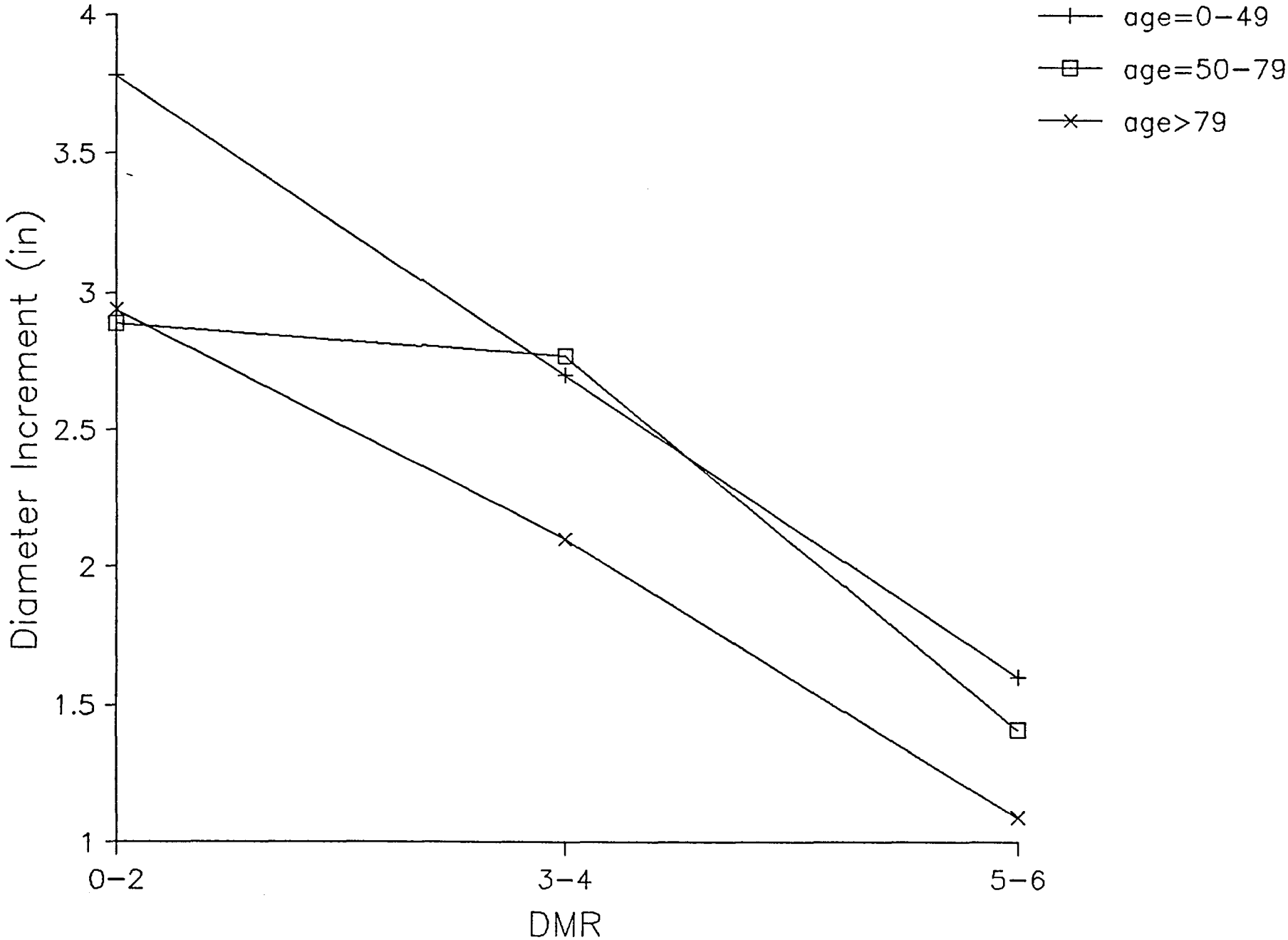

dbh=0-5.9 in
dbh=6-11.9 in
dbh>11.9 in
Diameter Increment (in)
3.8
3.3
2.8
2.3
1.8
1.3
0-2
3-4
5-6
DMR

MALHEUR DATA
Mean Diameter Increase (1973-1988)

age73		DMR 0-2	3-4	5-6
0-49 yr	+ dia	3.7774	2.6952	1.62
	n	93	42	10
50-79 yr	+ dia	2.888	2.7688	1.4125
	n	100	16	24
>79 yr	+ dia	2.9429	2.1	1.0889
	n	7	1	9

Table 5

Figure 5


age=0-49
age=50-79
age>79
Diameter Increment (in)
4
3.5
3
2.5
2
1.5
1
0-2
3-4
5-6
DMR

MALHEUR DATA

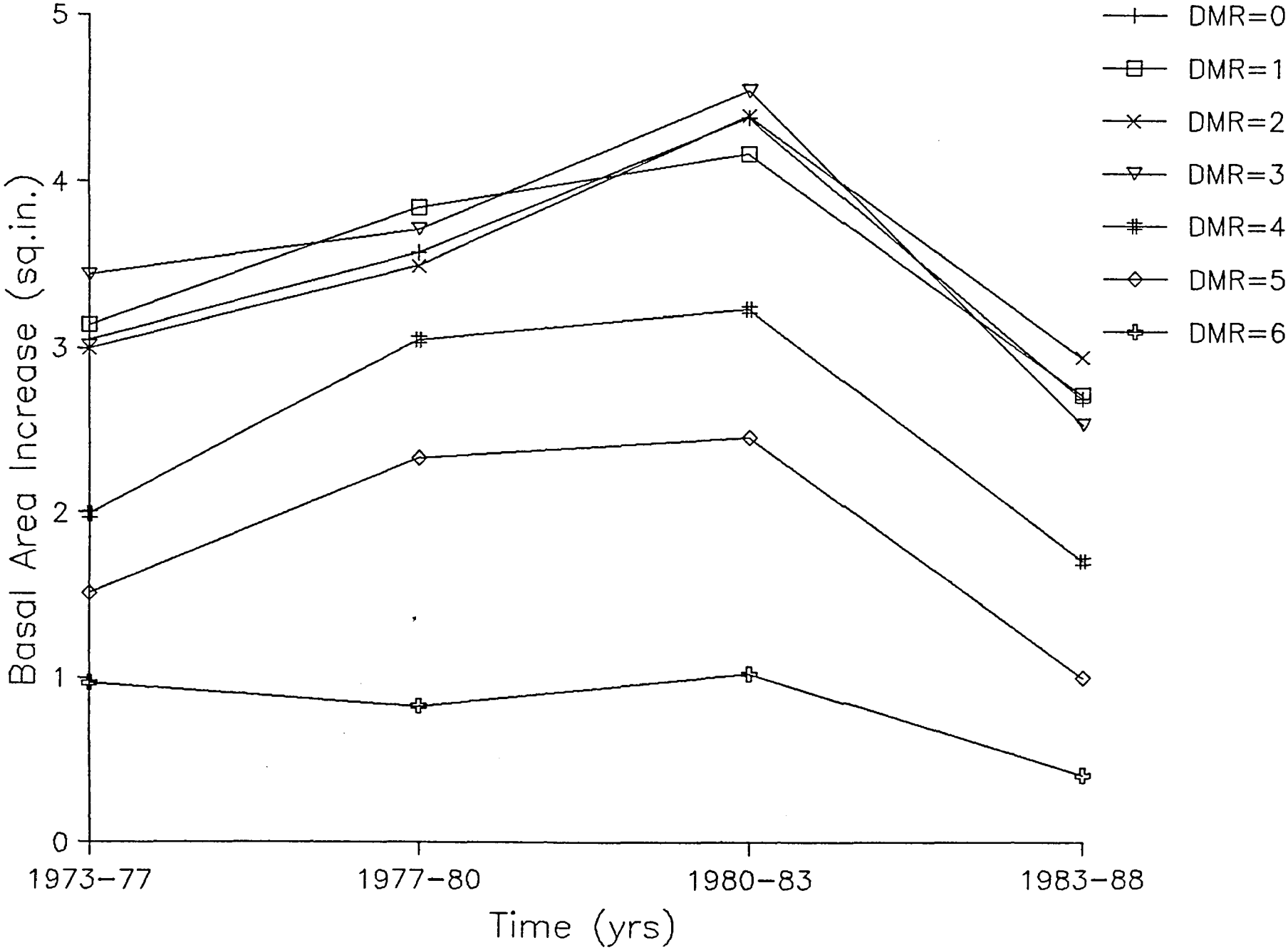
Data Summary Intervals

	1973-77	1977-80	1980-83	1983-88	n	DMR
Mean '73 dia.	7.88652					
Total BAI	1086.21	953.23	1170.02	1198.06	89	0
Mean annual BAI	3.05114	3.57015	4.38208	2.69227		
Mean IR*	0.338793	0.203752	0.196972	0.166516		
Mean '73 dia.	7.68542					
Total BAI	603.767	553.447	599.589	650.702	48	1
Mean annual BAI	3.14462	3.84338	4.16381	2.71126		
Mean IR*	0.953307	0.227719	0.207332	0.171164		
Mean '73 dia.	7.74722					
Total BAI	431.906	376.646	474.6	528.306	36	2
Mean annual BAI	2.99935	3.48746	4.39445	2.93503		
Mean IR*	0.288995	0.20876	0.23372	0.176639		
Mean '73 dia.	8.552					
Total BAI	687.318	556.407	680.257	633.227	50	3
Mean annual BAI	3.43659	3.70938	4.53505	2.53291		
Mean IR*	0.350993	0.185625	0.193895	0.138205		
Mean '73 dia.	7.11111					
Total BAI	214.877	247.22	261.663	229.014	27	4
Mean annual BAI	1.9896	3.0521	3.23041	1.6964		
Mean IR*	0.274333	0.227915	0.20138	0.141008		
Mean '73 dia.	6.928					
Total BAI	150.529	174.39	183.838	124.376	25	5
Mean annual BAI	1.50529	2.3252	2.45118	0.995005		
Mean IR*	0.1817	0.171048	0.145696	0.0923628		
Mean '73 dia.	6.54074					
Total BAI	104.835	67.5364	82.7103	55.5826	27	6
Mean annual BAI	0.970694	0.833783	1.02111	0.411723		
Mean IR*	0.125658	0.0821607	0.08551	0.0513808		

*Mean increment ratio (increase relative to BA at beginning of interval

Table 6

Figure 6


Basal Area Increase (sq.in.)
0
1
2
3
4
5
1973-77
1977-80
1980-83
1983-88
Time (yrs)
DMR=0
DMR=1
DMR=2
DMR=3
DMR=4
DMR=5
DMR=6

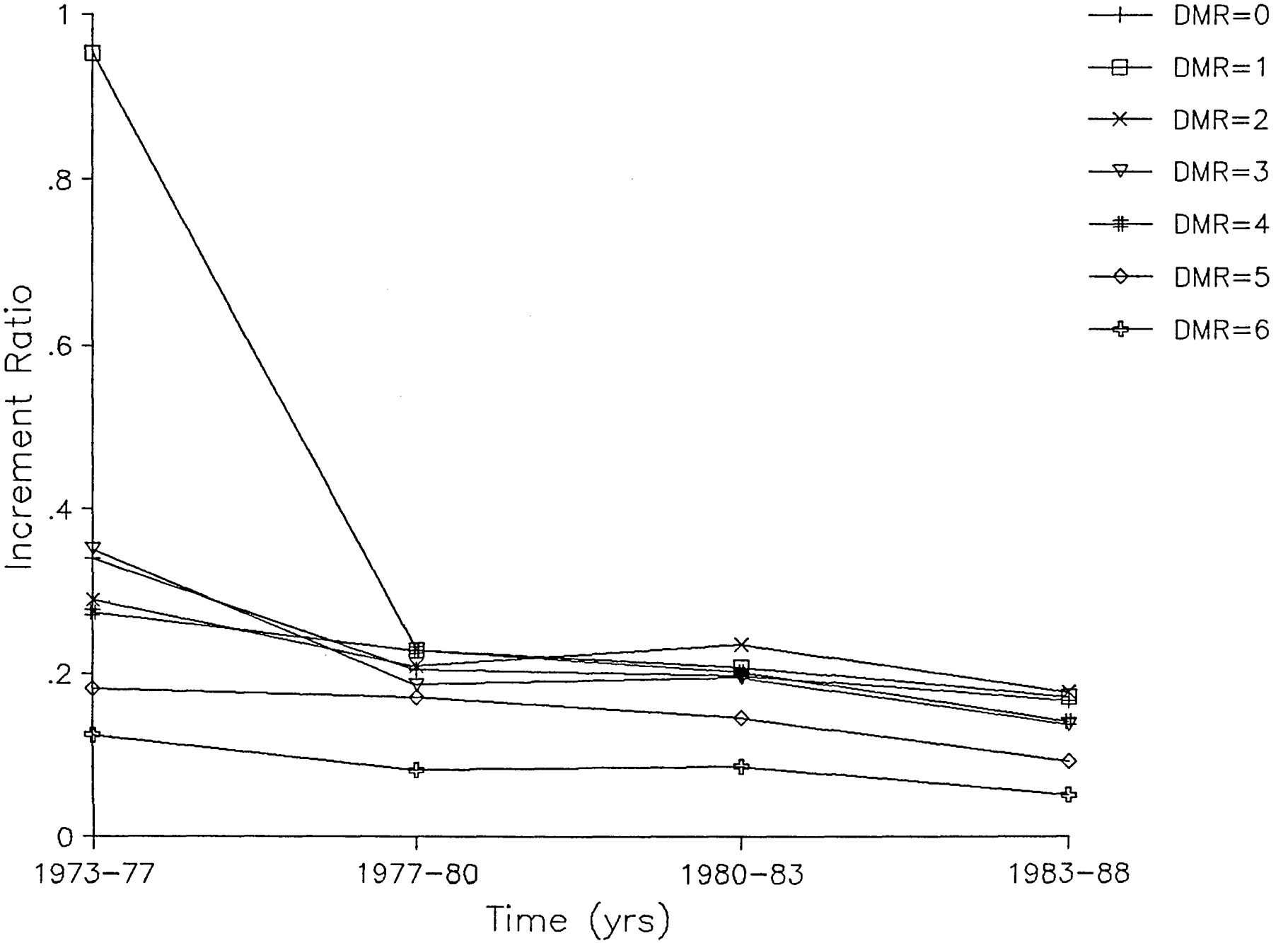
MALHEUR DATA

Data Summary by Site Location

	Sites 1-3	Sites 4-6	Sites 7-9	Sites 10-12
Sample Size	77	76	72	77
mean dbh, 1973	8.13506	6.89342	8.29583	7.42208
BAI 1973-77	11.1851	13.0178	11.2633	8.02442
BAI 1977-80	8.75933	11.1899	11.1217	7.83399
BAI 1980-83	9.04054	11.4006	13.8262	11.6185
BAI 1983-88	8.88489	15.0187	15.9245	5.80715
Mean DMR, 1983	1.28571	1.73684	2.06944	2.88312
Mean DMR, 1988	1.46753	1.77632	2.375	3.19481

Table 7

Figure 7


1
.8
.6
.4
.2
0
Increment Ratio
1973-77
1977-80
1980-83
1983-88
Time (yrs)
DMR=0
DMR=1
DMR=2
DMR=3
DMR=4
DMR=5
DMR=6

Malheur 1988 data

Plot	Tree	Age 1973	dbh (in) 1973-4	1977	1983-4	1988	Ht (ft) 1973	Ht Class 1983	1988	Inf'd 1973	DMR 1983-4	1988
1	1	46	5.4	5.7	6.2	6.4	33	1	0	+	6	6
1	2	41	3.6	4.7	6.5	7	26	2	0	+	2	2
1	3	47	7.3	9	11.2	12.1	45	3	2	-	0	1
1	4	54	7.9	9.2	11.6	12.3	34	2	0	+	4	4
1	5	51	7.5	6.5	8	8.5	40	2	0	-	1	2
1	6	46	7.4	9	11	12.3	43	3	0	-	0	0
1	7	64	9.8	11.2	12.7	13.6	54	2	0	-	0	0
1	8	62	8	8.6	9.5	10	55	1	2	+	2	1
1	9	43	4.9	6	8.3	9.1	39	3	0	-	0	0
1	10	44	5.6	6.1	7.5	8	40	2	0	-	0	0
1	11	51	11.7	13.2	15.2	16.4	69	3	0	-	0	0
1	12	49	5.9	6.7	8.3	9	40	2	0	-	0	0
1	13	41	7.4	8.9	11.1	12.2	42	3	0	-	0	0
1	14	79	12.7	13	14.5	15	57	2	2	+	2	3
1	15	74	13.4	14	14.9	15.1	53	2	0	+	3	3
1	16	40	4	4.6	5.5	5.9	29	1	0	-	0	0
1	17	58	11.7	12.3	13.2	13.6	57	1	0	+	2	1
1	18	67	9.4	10.1	11.2	11.5	42	2	0	+	2	1
1	19	62	9.5	10.4	12	12.4	61	2	0	-	0	0
1	20	80	17.4	18.4	19.6	20.3	75	2	0	+	1	1
1	21	47	8.7	9.3	10.6	11	51	1	0	-	0	0
1	22	55	14.2	15.1	16.4	17	63	3	2	-	0	0
1	23	53	11.8	12.9	15	16	62	2	0	-	1	1
1	24	53	9.2	9.9	11	11.3	54	1	0	-	0	0
1	25	51	8	8.5	9.2	9.5	48	2	0	-	0	0
1	26	51	9.5	10.2	11.2	11.6	51	2	0	-	0	0
1	27	51	5.2	5.3	5.9	6	35	3	1	-	0	0
1	28	48	8	9.2	10.6	11.8	53	2	0	-	0	0
2	1	63	9.2	10	11.2	11.6	56	3	0	+	2	1
2	2	60	11.8	12.2	14	15	55	3	2	+	1	1
2	3	79	21.6	22.7	23.6	24.5	87	2	2	+	2	2
2	4	48	5.2	5.8	6.7	6.9	37	2	1	+	1	0
2	5	45	8	9	10.4	11.2	38	3	2	-	0	1
2	6	43	5.2	5.9	7.1	7.3	31	2	1	-	0	0
2	7	61	7.5	8.9	10.3	11.1	45	3	1	-	0	0
2	8	53	8.5	9.5	10.6	10.8	45	3	0	-	0	0
2	9	46	7.1	8.3	9.8	10.3	37	3	0	+	1	0
2	10	46	9.5	10.8	11.8	12.1	42	3	0	+	3	3
2	11	35	6.6	8	9.7	10.2	39	3	0	-	0	0
2	12	32	3.6	4.4	5.4	5.6	26	1	0	-	0	0
2	13	44	8.4	9.7	10.8	11.3	49	2	0	+	2	2
2	14	39	7.1	8.4	9.9	10.5	39	3	0	+	1	1
2	15	30	3.1	3.7	4.8	5.1	24	2	0	-	0	1
2	17	45	6.7	7.8	9.4	9.6	42	3	1	+	1	1
2	18	55	11	12	13	13.4	55	2	1	+	1	3
2	19	42	8.4	9.2	9.5	9.8	40	3	1	+	3	3
2	20	56	8.9	10	11.1	11.4	38	3	1	-	0	0
2	21	56	13	13.8	15.3	15.9	59	3	2	-	0	0
2	22	51	8.5	9.2	10	10.3	50	3	1	-	0	0

Table 8

Malheur data continued

Plot	Tree	Age 1973	dbh (in) 1973-4	1977	1983-4	1988	Ht (ft) 1973	Ht Class 1983	1988	Inf'd 1973	DMR 1983-4	1988
2	23	61	11.7	12.4	13.2	13.8	57	3	2	-	0	0
2	24	57	8.8	9.5	10.3	10.7	53	3	2	+	1	1
2	25	61	10.4	11.5	12.1	12.1	55	2	0	-	1	0
3	1	54	8.8	9.5	10.6	11.3	52	3	2	-	0	0
3	2	56	8.7	9.4	10.6	11.2	49	3	2	-	0	1
3	3	52	6.8	7.9	9.4	10.1	38	3	3	-	0	0
3	4	58	6.9	7.4	8.3	8.8	38	2	2	-	0	0
3	5	53	7.8	8.5	9.4	10.5	37	3	2	-	1	0
3	6	47	6.4	6.6	6.9	6.9	40	0	0	+	6	6
3	7	58	11.3	11.9	13.2	13.8	54	3	1	+	3	3
3	8	56	4.2	4.6	5.1	5.3	27	1	0	+	5	5
3	9	45	4.7	5.4	6.4	6.8	25	2	0	+	4	4
3	10	61	7.8	8.8	10.1	10.7	41	2	1	-	2	3
3	11	53	6.1	6.8	7.7	8	48	1	1	+	5	5
3	12	56	8.1	9.1	9.9	10.3	33	2	2	-	0	2
3	13	53	5.9	6.7	7.5	7.8	32	2	1	+	1	2
3	14	46	6	6.3	7.1	7.8	29	2	2	+	1	5
3	15	44	5.1	5.2	5.4	5.5	30	0	0	+	6	6
3	16	56	6.6	7.3	7.9	8.1	37	1	1	+	5	6
3	17	57	4.6	5.3	6.4	6.9	30	3	1	+	1	4
3	18	51	4.5	4.7	5.1	5.1	36	1	1	+	6	6
3	19	60	6.6	6.9	7.5	7.7	45	1	1	+	2	3
3	20	60	7.6	8.8	9.9	10.7	55	3	2	-	0	1
3	21	64	5.3	5.9	6.5	6.6	40	1	1	+	3	4
3	22	58	8	8.7	9.7	10.5	52	3	2	-	0	0
3	23	65	8.7	9.2	9.8	10.2	52	2	1	+	1	1
3	24	63	7.5	7.8	8.5	8.7	54	2	1	+	1	0
3	25	53	7.5	8.4	9.5	10.1	45	3	1	-	0	0
4	1	38	5.5	6.3	7.4	8	26	3	1	+	2	2
4	2	53	6.9	7.8	9.9	10.5	33	3	3	-	1	0
4	3	48	10	10.3	10.8	10.9	44	1	1	+	3	3
4	4	48	8.1	9	10.6	11.6	44	3	0	-	0	0
4	5	66	8.3	9.2	10.4	10.8	45	3	2	-	0	0
4	6	66	9.7	10	11.2	11.8	44	3	0	+	2	1
4	7	63	7.5	7.9	8.8	9.3	45	2	2	-	0	0
4	8	78	15.8	15.9	16.8	17.3	75	1	1	+	4	0
4	9	63	7.5	8.2	9.3	10.1	50	3	2	-	0	0
4	10	68	10.3	11	12.2	13.1	60	2	1	-	0	0
4	11	14	2.7	3.5	5	5.6	13	3	0	-	0	0
4	12	46	6.3	7.3	8.8	9.7	33	3	0	-	0	1
4	13	56	4.9	5.3	5.6	6	21	0	0	+	6	6
4	14	43	4.5	4.9	5.7	6.1	22	1	1	+	4	4
4	15	5	1.1	1.2	1.8	2.1	7	3	0	+	1	2
4	16	15	0.6	3.1	4.7	5.4	13	3	2	-	0	1
4	17	23	1.8	3.8	5.3	6.3	15	3	2	+	1	1
4	18	73	5.9	6	6.3	6.5	23	0	0	+	6	6
4	19	12	1.6	2.3	3.3	3.8	11	2	1	+	3	4
4	20	39	4.8	5.5	6.9	7.4	27	3	0	+	2	1
4	21	33	2.7	3.3	4.5	5.1	16	3	0	+	2	2

Malheur data continued

Plot	Tree	Age 1973	1973-4	dbh (in) 1977	1983-4	1988	Ht (ft) 1973	Ht Class 1983	1988	Inf'd 1973	1983-4	DMR 1988
4	22	21	0.7	1.5	2.6	3.2	8	3	2	-	0	0
4	23	125	15.5	16.1	17.7	18.6	67	1	2	+	2	0
4	24	28	3.2	3.9	5.1	5.8	17	2	0	-	0	0
4	25	36	4.1	5.1	6.7	7.6	22	0	2	-	0	0
4	26	36	6.3	7	8.4	9.2	28	3	0	-	0	0
5	1	35	5.5	6.8	8.5	9.3	29	3	1	+	3	3
5	2	40	8.6	10	12.3	13.6	40	3	0	+	2	1
5	3	40	10.4	12.7	15.2	16.6	40	3	3	+	2	2
5	4	38	10.7	13	15.6	17.7	40	3	2	+	2	3
5	5	18	3.7	5.2	7.1	8.4	17	3	0	+	3	3
5	6	66	16.3	16.9	18.7	20.3	74	3	1	+	2	3
5	7	36	8.3	9.9	11.5	12.3	38	3	0	+	2	1
5	8	37	7.1	9	11.4	12.6	33	3	1	+	3	3
5	9	46	5.1	5.8	6.5	7.1	29	3	0	+	3	4
5	10	50	8	9.6	12	13.1	48	3	3	-	0	1
5	11	23	1.9	4.1	6.4	7.3	13	3	3	+	3	3
5	12	40	8.4	10.4	13	14.2	42	3	3	-	0	0
5	13	56	10.5	11.9	13.8	14.8	50	3	1	-	1	1
5	14	28	5.1	6.9	9.3	10.8	22	3	3	-	0	0
5	15	13	2.5	5.4	7.6	9.2	15	3	0	+	1	1
5	16	19	5.3	7.6	11.3	13.2	20	3	3	+	2	1
5	17	36	7.6	9.3	11.5	12.5	41	3	2	-	0	0
5	18	49	10.1	11.5	12.9	13.7	45	3	1	+	3	4
5	19	42	7.7	8.4	9.8	10.5	40	3	1	+	3	2
5	20	41	8.5	9.7	11.4	12	44	3	0	-	0	2
5	21	40	8.5	9.8	11.7	12.7	40	3	3	+	1	2
5	22	43	6.3	7.5	9.3	10.2	37	3	3	+	1	1
5	23	48	8.5	10.2	12.5	13.4	34	3	2	+	2	3
5	24	75	10.6	11.4	13	13.9	41	3	2	+	2	1
5	25	48	8.3	9.7	11.1	11.5	41	3	1	+	3	3
6	1	52	6.9	7.9	9.3	9.9	35	3	2	+	3	3
6	2	13	3.2	3.9	5.1	5.6	14	3	1	+	3	5
6	3	56	7.2	7.9	9.1	11.1	39	3	2	+	3	3
6	4	58	10.1	11.3	12.9	13.9	46	3	2	-	2	1
6	5	46	7.3	8.4	10.2	11.4	40	3	2	+	1	1
6	6	42	5.8	6.3	6.8	7.2	35	1	1	+	5	5
6	7	56	7.4	7.8	8.4	8.9	44	2	1	+	4	4
6	8	55	6.1	6.3	6.9	7	36	2	1	+	4	5
6	9	61	7.8	8.3	9.3	10.2	43	3	1	+	2	1
6	10	83	11.6	12.4	13.2	14.1	57	3	1	+	2	2
6	11	36	4.4	5	6.1	6.7	31	3	1	+	2	3
6	12	66	6.9	7.8	9.5	10.4	37	3	3	+	2	2
6	13	35	6.8	7.9	9.3	10.2	34	3	2	+	1	3
6	14	43	7.5	8.6	10.3	11.2	38	3	2	+	3	3
6	15	33	4.9	5.7	7.4	8.4	27	3	3	+	1	1
6	16	44	8	9.1	10.8	12	43	3	2	-	1	0
6	17	42	6.9	8	9.4	10.3	38	3	2	-	0	0
6	18	30	7	8	9.8	11.2	33	3	3	-	0	0
6	19	21	6.9	8.3	10.2	11.4	28	3	3	-	0	0

Malheur data continued

Plot	Tree	Age 1973	dbh (in) 1973-4	1977	1983-4	1988	Ht (ft) 1973	Ht Class 1983	1988	Inf'd 1973	1983-4	DMR 1988
6	20	25	8.6	10.9	14	15.6	32	3	3	+	2	2
6	21	24	6.1	7.5	9.4	10.8	20	2	2	+	2	2
6	22	31	5.8	6.4	6.9	7.3	22	1	0	+	5	6
6	23	52	8.4	9.8	11.3	12	32	3	1	+	1	1
6	24	35	10.2	12.5	15.1	16.4	37	3	3	-	0	0
6	25	17	2.3	4.4	6.1	7.3	14	3	3	-	0	0
7	1	40	7	8	9.9	11.4	43	3	2	-	0	0
7	2	37	6.2	7.5	9.7	11	37	2	2	-	0	1
7	3	31	4.4	5.7	8.2	9.5	28	3	2	-	0	0
7	4	52	6	6.8	9	10.5	43	3	3	-	0	0
7	5	39	8	8.8	10.7	12	43	3	1	+	1	0
7	6	43	6.9	8.3	10.5	11.4	33	2	2	+	1	1
7	7	56	7.4	8	9.9	11.3	21	2	1	+	1	3
7	8	26	4.9	6	7.9	8.2	25	1	1	+	5	6
7	10	21	4.3	4.8	6.2	6.9	20	2	1	+	4	5
7	11	34	5.6	6.1	7.6	8.7	34	3	1	+	4	4
7	12	28	5.8	6	6.8	7.1	35	2	1	+	2	2
7	13	71	8	8.6	9.3	10	43	0	0	+	6	6
7	14	96	16.9	17.3	18.6	19.5	84	1	1	+	4	4
7	15	46	5.2	5.7	7.1	8.2	34	2	1	+	2	2
7	16	46	9.1	10.1	12.2	13.4	46	3	2	+	1	2
7	17	80	11.1	11.4	12.7	13.2	60	2	1	+	3	3
7	18	55	9.5	10.3	11.8	12.7	51	2	2	+	2	2
7	19	68	6.9	7.3	8.6	8.9	38	1	1	+	2	3
7	20	28	2.7	3.4	5	5.5	25	2	1	+	2	4
7	21	34	4.1	5	6.8	7.7	32	3	2	+	1	1
7	22	51	7.5	8.7	11.8	13.1	48	3	3	-	0	0
7	23	36	5.3	6.2	9.7	10.3	32	3	2	+	2	2
7	24	45	6.5	7.9	11	12.3	39	3	2	-	0	0
7	25	54	7.5	8.7	10.9	11.6	45	3	2	-	0	0
8	1	51	9.2	10	12	13	57	3	2	-	0	0
8	2	46	7.1	8.1	9.7	10.4	34	2	1	+	4	5
8	3	79	13.5	15.2	17.2	18.3	60	2	1	+	3	3
8	4	61	7.1	7.8	9.3	10.3	40	1	1	+	3	4
8	5	57	8.3	9.8	12.6	14.2	40	3	2	+	1	2
8	6	52	6.3	7.3	9.1	10	35	2	1	+	4	5
8	7	61	9.9	11.2	13.4	14.7	48	2	2	+	2	3
8	9	56	6	7	9.1	9.8	34	1	1	+	5	5
8	10	68	12.8	14	15.6	16.5	65	1	1	+	2	3
8	11	48	9.1	9.9	11.7	13	48	3	2	+	1	2
8	13	81	14	14.7	16	17.3	66	2	1	-	1	1
8	14	73	11.1	11.6	12.6	13.2	60	1	1	+	2	2
8	15	51	5.2	5.6	6.5	7	30	1	0	+	5	6
8	16	83	11.8	12.5	13.7	14.9	55	2	2	+	2	2
8	17	68	10.5	10.6	11.6	12.4	55	1	2	+	3	3
8	18	72	9	9.5	10.6	11.4	50	2	2	-	0	0
8	19	58	8.1	8.8	10	10.7	34	2	2	-	0	0
8	20	47	10.5	11.8	14.3	15.3	34	3	2	-	0	0
8	21	45	9.3	10.3	12.2	13.5	40	2	2	-	0	0

Malheur data continued

Plot	Tree	Age 1973	dbh (in) 1973-4	1977	1983-4	1988	Ht (ft) 1973	Ht Class 1983	1988	Inf'd 1973	DMR 1983-4	1988
8	22	58	9.8	10.5	12.6	13.7	32	2	1	+	1	1
8	23	51	7.9	8.3	10.1	10.9	51	3	2	-	0	1
8	24	53	7	11.8	13.7	14.8	51	2	1	+	2	3
8	25	59	12.7	14.1	16.2	17.7	65	3	2	-	0	0
9	1	66	12.3	13.6	15.3	16.2	48	2	2	+	4	3
9	2	70	10.2	10.9	11.7	12.5	40	1	1	+	2	2
9	3	66	12.9	13.6	15.1	16.2	50	2	1	+	1	2
9	4	53	8.8	8.9	9.6	10.1	40	1	2	-	0	0
9	5	61	9.2	9.3	9.3	9.3	40	0	0	+	6	6
9	6	36	6.8	7.7	9.2	9.7	35	1	1	+	3	5
9	7	67	8.4	8.4	8.4	8.4	30	0	0	+	6	6
9	8	76	10.3	10.4	10.8	10.8	45	1	1	+	5	5
9	9	73	7.6	7.6	7.9	7.9	30	0	0	+	6	6
9	10	71	7.5	7.6	8	8	38	1	0	+	5	5
9	11	42	8.7	9.9	11.9	13	35	2	2	-	0	0
9	12	48	6.2	6.9	8	8.6	30	1	1	+	4	4
9	13	61	5.8	6.3	7.1	7.1	30	1	0	+	5	6
9	14	71	6.7	6.8	7.4	7.7	25	0	0	+	6	6
9	15	56	8.7	8.7	9	9.3	45	1	1	+	5	5
9	16	33	5.5	6.6	9.1	9.9	35	2	3	-	0	0
9	17	60	6.5	7.3	9.3	10.3	40	2	3	-	0	0
9	18	46	6.9	7.4	9.3	10.7	40	3	2	-	1	0
9	19	58	7.7	8.5	10.3	11.1	40	1	1	+	3	5
9	20	71	8.4	9.5	11.6	13	45	3	3	-	0	0
9	21	83	9.9	10.6	11.7	13.7	50	2	2	-	0	0
9	22	78	9.9	10.6	12.5	13.3	45	3	2	-	0	0
9	23	65	7.5	8	9.6	10.5	40	2	2	-	0	0
9	24	63	9.2	9.6	10.6	11.1	50	1	1	+	3	3
9	25	63	12.7	13.6	15	15.5	65	3	1	-	0	0
10	1	44	3.1	4	6	6.7	15	2	1	+	3	4
10	2	43	7.2	8.7	11.4	12.2	35	3	2	-	3	3
10	3	73	10.3	11.5	14.1	14.7	45	3	1	+	3	4
10	4	38	3.4	3.9	5.3	5.7	15	2	2	+	2	3
10	5	26	1.8	2.7	4.4	5.3	10	3	2	+	2	2
10	6	38	1.9	2.5	3.9	4.6	10	2	2	-	0	0
10	7	38	3	3.6	5	5.5	15	2	1	+	2	3
10	8	33	3.5	4.3	6.4	7.5	15	3	2	-	1	1
10	9	43	4.7	5.4	7.1	7.3	25	2	1	-	0	1
10	10	35	5.5	6.1	8.1	8.8	20	3	2	-	2	3
10	11	71	7.9	8.1	8.3	8.3	30	0	0	+	4	5
10	12	73	12.2	13	14.7	15.1	45	2	1	+	3	3
10	13	103	6.5	6.9	7.7	7.9	30	1	0	+	6	6
10	14	104	9.6	9.8	9.8	9.8	35	0	0	+	6	6
10	15	88	7.7	7.8	8.3	8.3	25	1	1	+	5	5
10	16	87	6.3	6.8	7.4	7.4	25	0	0	+	6	6
10	17	79	8.4	9.3	10.7	10.9	35	3	1	+	3	3
10	18	63	7	7.3	8.4	8.7	35	1	1	+	4	2
10	19	93	8	8.8	8.9	9	35	1	0	+	6	6
10	20	117	17.4	18.1	19.1	19.3	60	2	1	+	2	3

Malheur data continued

Plot	Tree	Age 1973	1973-4	dbh (in) 1977	1983-4	1988	Ht (ft) 1973	Ht Class 1983	1988	Inf'd 1973	1983-4	DMR 1988
10	21	68	10.7	11.4	12.7	12.9	40	1	1	+	5	5
10	22	49	4	4.2	5.2	5.8	18	1	0	+	5	6
10	23	58	5	5.8	8.3	8.7	25	2	2	+	5	4
10	24	48	3	3.9	6	6.9	25	2	2	+	2	3
10	25	28	3.1	3.8	6.1	7.1	12	2	2	+	2	1
10	26	48	6.2	7.1	9.2	9.7	25	2	1	+	5	5
10	27	60	9.9	10.8	12.5	12.7	35	1	1	+	5	5
10	28	108	8.3	8.5	9.2	9.3	45	0	0	+	6	6
10	29	105	10.3	10.8	12.2	12.7	50	2	1	+	5	4
11	1	68	6.5	6.9	8.3	8.5	40	2	1	-	0	1
11	2	67	9.7	10.1	11.3	11.6	45	2	1	+	3	3
11	3	53	9.8	11	12.3	12.8	40	2	1	-	1	1
11	4	70	5.9	6.2	7.2	7.4	30	2	1	+	2	2
11	5	88	14.8	15.2	16.1	16.4	55	1	0	+	5	4
11	6	83	11.2	11.5	12.3	12.4	45	1	1	+	4	4
11	7	47	5.1	5.7	7.4	7.9	30	2	2	-	1	3
11	9	28	5.9	7.4	10.1	10.9	30	2	1	+	2	2
11	10	43	9.6	10.3	12.1	12.5	40	3	1	+	2	3
11	11	38	6.7	7.9	10.2	10.9	30	3	1	+	1	2
11	12	63	6.4	6.9	9	9.5	25	3	1	-	2	3
11	13	44	6.8	7.4	9	9.3	35	2	1	+	5	5
11	14	58	4.8	5.3	6.8	7.1	20	2	1	+	4	4
11	17	78	3	3.3	3.8	3.8	20	1	1	+	6	6
11	18	73	4.8	5.1	6	6.2	30	1	0	+	4	5
11	19	83	10	10.1	10.5	10.5	55	1	0	+	6	6
11	20	73	10.7	11.2	12.4	12.7	60	2	1	+	4	5
11	21	45	5.3	5.5	5.6	5.6	35	0	0	+	6	6
11	22	60	5.9	6.3	7	7.1	35	1	1	+	6	6
11	23	68	6.7	7.1	8	8.1	30	1	1	+	4	5
11	24	63	6	6.6	8.1	8.6	30	3	1	-	0	0
11	25	66	6.9	7.7	9.1	9.5	35	2	1	+	2	3
12	1	38	4.4	5.1	6.8	7.3	15	2	1	+	3	4
12	2	50	9.9	10.9	12.6	13.4	35	2	1	+	4	4
12	3	50	5.7	6.3	7.8	8.2	25	1	1	+	5	5
12	4	76	9.3	10.4	11	11.3	35	1	1	+	6	6
12	5	63	10.8	11.6	12.9	13.3	45	2	2	+	3	3
12	6	61	6.8	7.5	9.1	9.5	35	3	2	+	1	2
12	7	48	6.7	7.2	8.5	8.7	30	3	1	+	2	4
12	8	60	7.1	7.6	9.3	9.7	35	3	2	-	0	0
12	9	69	9.2	9.9	11.5	12	40	3	1	+	1	1
12	10	47	7.5	8.1	9.7	10	35	3	2	-	0	0
12	11	58	7.7	8.4	10	11.5	40	3	2	+	2	2
12	12	72	8.3	9.4	11.3	11.9	30	3	2	-	0	0
12	13	73	9.6	10.3	11.5	11.5	45	3	1	+	0	0
12	14	82	7.9	8.3	9.2	9.3	40	2	1	+	4	3
12	15	66	8.9	9.5	10.9	11.1	45	3	1	+	4	4
12	16	61	6.1	6.7	8.3	8.7	30	2	1	+	1	2
12	17	65	8.6	9.3	10.6	10.9	55	3	1	-	0	0
12	18	73	11.6	12.2	13.3	13.4	55	3	1	+	2	3

Malheur data continued

		Age	dbh (in)				Ht (ft)	Ht Class		Inf'd		DMR	
Plot	Tree	1973	1973-4	1977	1983-4	1988	1973	1983	1988	1973	1983-4	1988
12	19	62	7.3	7.8	8.9	9.1	40	2	2	+	0	1
12	20	75	14.4	15.5	17.5	17.7	65	3	2	-	0	0
12	21	63	8.8	9.5	11.3	11.6	45	2	1	-	1	1
12	22	68	10.2	11	12.7	13	55	3	2	-	0	0
12	23	53	6.3	7	8.7	9.2	35	3	1	+	2	3
12	24	43	5.8	6.6	8.6	9.3	30	2	1	+	4	4
12	25	40	7.1	8	10.3	10.7	40	2	2	+	1	3
12	26	63	7.1	7.5	8.6	9.6	30	2	1	+	3	4

Hayseed 1988 data

plot	tree	dbh (cm)	ht (m)	top gw (cm)	crn cls	DMR (lower,middle,upper)		
1	1	8.3	5.5	25	100	0	0	0
1	2	5	4	18	90	0	0	0
1	3	7.6	4.3	13	100	1	0	0
1	4	13.3	7.3	25	100	0	0	0
1	5	12.3	6.7	20	100	0	0	0
1	6	6	4.6	20	100	0	0	0
1	7	7.3	6.1	18	100	0	0	0
1	8	4.4	3	13	100	0	0	0
1	9	9.2	6.7	18	100	0	0	0
1	10	7	4.9	8	100	0	0	0
1	11	11.8	5.8	5	100	2	0	0
1	Larix occidentalis 14.5							
2	12	3.5	2.4	20	90	0	0	0
2	13	3.5	3	30	100	0	1	0
2	14	3.5	2.4	25	100	0	0	0
2	15	2.5	2.7	25	90	0	0	0
2	16	14.8	7.9	20	100	1	0	0
2	17	9.3	7	10	80	1	0	0
2	Pseudotsuga menziesii small							
2	note: needle cast present							
3	18	8.2	7	8	70	2	0	0
3	19	3.9	4.9	8	70	0	0	0
3	20	3.9	2.4	13	90	0	0	0
3	21	10.6	7.9	8	90	1	0	0
3	Pseudotsuga menziesii 18.5 infected							
3	Pseudotsuga menziesii 20.1 infected							
3	Pseudotsuga menziesii 19.5 infected							
3	note: broom off 18							
4	22	10	5.8	5	60	2	0	0
4	23	9.2	7.6	8	70	2	0	0
4	24	9.4	7.9	13	80	2	0	0
4	25	7.9	7.3	18	80	1	0	0
4	26	10.8	8.5	13	70	2	1	0
4	27	8.5	7	18	70	1	0	0
4	28	10	6.7	13	70	2	1	0
4	29	10.8	8.5	8	80	2	2	0
4	note: no tag #30							
4	31	14.4	10.7	10	80	1	0	0
4	32	8.7	7	5	50	2	0	0
4	33	12.8	9.8	10	80	2	0	0
4	note: broom off 22							
4	note: broom off 33							
5	34	8.8	7.3	10	50	0	1	0
5	35	8.9	6.7	20	40	0	0	0
5	36	9.2	6.1	20	50	0	0	0
5	37	10.2	6.7	13	60	0	0	0
5	38	8.5	6.7	20	60	0	0	0
5	39	8	4.6	0	50	1	0	0
5	40	10.4	7.3	8	70	1	0	0
5	41	8.5	7.3	20	80	1	1	0
5	note: tree 39 badly damaged, top broken							
5	Pseudotsuga menziesii 19 infected							
5	Pseudotsuga menziesii 17 infected							

Table 9

hayseed data continued

plot	tree	dbh (cm)	ht (m)	top gw (cm)	crn cls	DMR (lower,	middle,	upper)
6	42	5.2	4	15	70	2	0	0
6	43	4	3	20	90	0	0	0
6	44	8.6	6.1	18	70	0	1	0
6	45	5.7	5.2	20	50	0	0	0
6	46	11.5	7.6	20	70	2	0	0
6	47	4.5	4.6	13	90	1	1	0
7	48	12	6.1	25	60	2	0	0
7	49	12	7.6	25	80	0	0	0
7	50	10.1	5.5	18	80	0	0	0
7	Pseudotsuga menziesii 17.8 infected							
7	Pseudotsuga menziesii 16							
7	Larix occidentalis 2							
8	200	9.3	5.5	10	90	2	1	0
8	51	11.3	7.3	20	70	0	0	0
8	1400	13.5	8.5	3	30	2	2	1
8	52	8.5	7	25	80	1	0	0
8	53	7.7	5.2	25	70	0	0	0
8	54	11	5.5	5	80	2	2	0
8	55	9.7	4.3	5	60	2	0	0
8	56	6.6	4.9	5	70	2	0	0
8	57	7.8	4.9	20	80	1	0	0
9	58	5.4	3	13	90	0	0	0
9	59	7.6	5.5	8	70	0	0	0
9	60	9	7.6	18	70	1	0	0
9	61	12.3	7.9	25	60	1	0	0
9	62	6.7	4	10	60	0	0	0
9	63	11.8	6.1	15	90	2	0	0
9	64	10.8	6.7	20	70	2	0	0
9	65	4.7	4.6	3	70	2	0	0
9	66	4.9	4	13	90	0	0	0
9	67	6.3	4.3	20	90	0	0	0
9	68	11.7	8.5	25	90	0	0	0
10	69	10.9	6.1	25	80	0	0	0
10	70	11	7.6	25	70	0	0	0
10	71	7.3	4.9	10	70	1	0	0
10	72	9.9	7	10	50	0	0	0
10	73	7.7	5.5	8	40	0	0	0
10	74	9.5	5.5	18	90	0	0	0
10	75	7.4	4.9	15	50	0	0	0
10	76	14	7.9	20	70	2	0	0
10	77	8	6.7	20	90	0	0	0
11	78	11.1	8.5	25	80	0	0	0
11	79	8.4	6.1	25	60	0	0	0
11	80	9.4	6.1	5	50	2	1	0
11	81	9.8	7.9	25	60	0	0	0
11	82	8.8	7.3	20	70	0	0	0
11	Pseudotsuga menziesii 17 infected							
11	Larix occidentalis 3							
11	Pseudotsuga menziesii 16.5							
12	83	10.2	6.1	5	80	2	2	1
12	84	8.8	4.6	5	70	2	2	0
12	85	10.2	5.5	5	60	2	2	1
12	86	10.4	7.9	20	90	2	1	0

Table 9 cont.

hayseed data continued

plot	tree	dbh (cm)	ht (m)	top gw (cm)	crn cls	DMR (lower,middle,upper)		
12	87	5.5	4.9	8	70	2	0	0
12	88	10.8	8.2	18	80	0	0	0
12	199	7.5	4.9	10	60	2	0	0
12	89	14	9.1	20	60	2	0	0
12	90	10	7.3	18	80	2	0	0
13	91	8.6	7.6	20	90	2	1	0
13	92	6.6	5.5	15	90	0	0	0
13	93	12.7	10.7	25	90	1	0	0
13	94	7.9	6.1	13	60	1	2	0
13	Pseudotsuga menziesii 1							
13	Pseudotsuga menziesii 25 infected							
13	Pseudotsuga menziesii 15.5							
13	Pseudotsuga menziesii 15.5							
13	Larix occidentalis 12							
14	95	3.4	3	3	70	2	1	0
14	96	3	3	13	100	0	0	0
14	97	6.9	5.2	15	90	2	1	0
14	98	12.7	8.2	25	100	2	0	0
14	99	3	3.4	13	70	0	0	0
14	100	10	7	10	70	0	0	0
14	Larix occidentalis 4							
14	Pseudotsuga menziesii small							
14	Pseudotsuga menziesii small							
15	101	12.8	7.9	20	90	2	0	0
15	102	5.9	5.5	18	80	0	0	0
15	103	8.5	6.1	20	90	0	0	0
15	104	7	5.2	13	50	2	0	0
15	105	8.8	5.5	20	90	0	0	0
16	106	7	8.5	15	90	2	2	0
16	107	12	8.2	20	60	0	0	0
16	108	6	6.1	20	80	0	0	0
16	109	8.5	6.1	25	90	2	0	0
16	110	7.3	7.3	25	80	0	0	0
16	111	7.8	6.1	20	80	0	0	0
16	112	10.1	7.3	25	90	2	0	0
16	113	9.1	6.1	10	80	1	0	0
16	Pseudotsuga menziesii 17.3 infected							
17	114	7.8	4.9	25	60	0	0	0
17	115	8.6	5.2	20	80	1	1	0
17	116	3.8	3	10	80	0	0	0
17	117	4.2	3.7	15	90	0	0	0
17	118	6.5	6.1	8	90	0	0	0
17	119	5.8	5.2	18	90	0	0	0
17	120	11.4	7.3	20	60	0	0	0
17	121	9.1	6.1	15	100	0	0	0
17	122	5.5	4.9	18	90	0	0	0
17	123	6	4.9	20	80	0	0	0
17	124	5.5	4.6	8	90	1	0	0
17	Pseudotsuga menziesii 16.1 infected							
17	Pseudotsuga menziesii 18 infected							
17	Pseudotsuga menziesii 17 infected							
17	note: no tag #125							
18	210	3.2	3	15	100	2	0	0

Table 9 cont.

hayseed data continued

plot	tree	dbh (cm)	ht (m)	top gw (cm)	crn cls	DMR (lower, middle, upper)		
18	126	9	5.5	18	100	2	0	0
18	Pseudotsuga menziesii small							
18	Pseudotsuga menziesii small							
18	larix occidentalis 16.5							
19	127	3	3	5	40	2	0	0
19	128	14.7	6.1	5	70	2	2	1
19	129	3.3	3	20	100	0	0	0
19	130	10.3	3.7	3	50	2	2	2
19	131	4.7	2.1	3	40	2	2	0
19	132	6	6.1	25	80	2	0	0
19	133	2.5	2.1	8	100	1	0	0
19	134	4.4	4.3	10	100	2	0	0
19	135	3	2.1	3	70	2	2	1
19	Pseudotsuga menziesii small							
19	Pseudotsuga menziesii small infected							
19	Pseudotsuga menziesii small							
20	136	9.8	5.5	5	60	2	1	0
20	137	5.1	4	15	90	0	0	0
20	138	10.3	6.7	13	70	1	1	0
20	139	5.1	4.3	25	100	1	1	0
20	140	12.2	6.1	25	70	2	0	0
20	141	9.6	5.5	20	50	0	0	0
20	142	10.1	5.5	5	50	2	2	0
20	Pseudotsuga menziesii small							
21	143	9.5	5.5	20	80	0	0	0
21	144	4.4	4.3	20	80	0	0	0
21	145	11.6	5.5	15	100	1	1	0
21	146	9.7	6.1	20	80	1	0	0
21	147	3.6	2.4	18	80	2	2	0
21	Pseudotsuga menziesii small							
21	Pseudotsuga menziesii small							
21	Pseudotsuga menziesii small							
21	Pseudotsuga menziesii 10 infected							
22	148	5.7	4.6	25	100	0	0	0
22	149	5.4	4.6	20	100	1	0	0
22	150	5.5	4.9	20	90	0	0	0
22	151	3.7	3.7	30	100	0	0	0
22	152	4.7	3.7	18	100	1	0	0
22	Pseudotsuga menziesii small							
22	Pseudotsuga menziesii small							
22	Pseudotsuga menziesii small							
22	Larix occidentalis 10.2							
23	153	4.5	3.4	13	60	0	0	0
23	154	8.4	9.1	10	70	0	0	0
23	155	7.5	8.2	8	60	0	0	0
23	156	3.7	3	8	90	0	0	0
23	157	5.9	6.7	8	60	0	0	0
23	158	4	2.7	10	90	0	0	0
23	159	3.7	2.7	18	60	0	0	0
23	160	6.5	5.8	30	100	0	0	0
23	161	11.7	7.3	20	70	0	0	0
23	162	3.3	2.7	13	80	0	0	0
23	163	11.4	8.2	30	60	0	0	0

Table 9 cont.

hayseed data continued

plot	tree	dbh (cm)	ht (m)	top gw (cm)	crn cls	DMR (lower,	middle,	upper)
23	164	2.6	2.1	13	100	0	0	0
23	165	4.6	5.8	15	90	0	0	0
23	166	12.5	10.4	20	70	0	0	0
23	167	3.5	3.4	15	70	0	0	0
23	168	5.9	5.5	15	60	0	0	0
23	169	3.3	2.4	18	100	0	0	0
23	170	4.7	6.1	25	60	0	0	0
23	Pseudotsuga menziesii small							
24	171	4.2	5.2	25	50	0	0	0
24	172	8.7	7	30	70	1	0	0
24	173	6.9	5.5	8	90	1	2	0
24	174	9.2	8.2	8	60	1	0	0
24	175	11.7	9.4	5	60	2	0	0
24	176	11.6	8.8	5	80	2	1	0
24	177	11.3	7.9	18	60	0	0	0
24	178	5.9	6.1	15	70	0	0	0
24	179	4.8	4.6	5	80	0	1	0
24	180	5.5	5.2	20	60	1	0	0
24	181	3.2	4	5	60	0	0	0
24	182	10.6	8.5	25	80	0	0	0
24	183	10.5	7.9	10	70	0	0	0
24	note: brooms off 173, 175							
24	note: butt scare on 177							
25	184	12.5	8.2	20	80	2	0	0
25	185	5.5	4.6	25	90	0	0	0
25	186	9.9	7	20	100	0	0	0
25	187	5.3	4.9	5	90	2	1	0
25	188	5.4	4.9	3	50	1	1	0
25	189	14.3	8.5	15	70	1	0	0
25	Larix occidentalis small							
25	Larix occidentalis 7.6							
25	Larix occidentalis 2							
25	Larix occidentalis 4.5							
25	Pseudotsuga menziesii 15.1							
26	190	11.9	8.5	13	70	0	0	0
26	191	9.5	6.1	10	50	0	0	0
26	192	9	5.5	18	70	0	0	0
26	193	7.7	6.1	18	70	0	0	0
26	194	11.5	7.9	10	40	0	0	0
26	note: no tag #195							
26	196	9	7	5	60	0	0	0
26	197	11.3	7	5	50	0	0	0
26	198	10.8	6.7	5	70	0	0	0
26	Pseudotsuga menziesii 15.1							
27	201	4.5	3.7	25	80	0	0	0
27	202	3.9	3	25	100	0	0	0
27	203	6.5	4.3	25	100	0	0	0
27	204	6.3	4	13	100	0	0	0
27	205	8	4.9	25	80	0	0	0
27	206	4.5	4	23	80	0	0	0
27	207	2.8	2.4	25	90	0	0	0
27	208	4	3.7	20	80	0	0	0
27	209	5.7	4	20	90	0	0	0

Table 9 cont.

ADDENDUM
to
Final Report
Cooperative Agreement 28-C8-445
Robert O. Tinnin
December 12, 1988

I have now completed three statistical tests that remained incomplete at the time I filed the final report. All of the data in the following sections are best evaluated by means of a nonparametric test. I have selected the Kruskall-Wallis (KW) test associated with the Dunn technique (to distinguish between treatments) as the most appropriate procedure. I was waiting for a computer program of the KW and Dunn tests to be completed. Data evaluation has yielded the following results:

Growth rate for trees of different infection class

Reference to figure 2 of the original report shows that trees of higher infection class appear to grow at a slower rate than trees of lower infection class in central Oregon. Preliminary evaluation showed a significant difference among DMR classes:

DMR class:	1	0	2	3	4	5	6
Sign. Diff.:	a	a	a	a	ab	bc	c

where there is no significant difference between any two DMR classes sharing a letter in common. These results have remained unchanged by further evaluation (Table 1 adden). The DMR classes are set in order of their ranking in the test. The heavily infected trees grow at a rate that is significantly slower than lightly/moderately infected trees. This comes as no surprise and is clearly consistent with the observed smaller diameters of heavily infected trees.

Response to environmental stress

Reference to figure 6 of the original report shows that trees of higher infection class appear to be less affected by environmental conditions than trees of lower infection class. Specifically, note that annual basal area increments all show a decrease in the 1983-88 growth period but that DMR class 6 shows less decrease, albeit growth of this class is already very slow. The results of the analysis are as follows:

DMR class:	3	0	1	2	5	4	6
Sign. Diff.:	ab	ab	ab	bc	bc	bc	c

The results are clouded (Table 2 adden), but there is a significant difference between the lightly infected trees and DMR class 6. I do not wish to make much of this observation, but it is interesting

ecologically. If the observation is valid, what is the nature of the interaction between the effects of the environment and the effects of infection by dwarf mistletoe on the host?

Performance ratio

Reference to figure 7 of the original report shows that trees of higher infection class appear to be performing less efficiently than trees of lower infection class. This is really just another way of viewing the reduced rate of diameter growth. Evaluation of these data between 1977 and 1988 yields the following results:

DMR class:	2	1	4	0	3	5	6
Sign. Diff.:	a	a	a	a	a	ab	b

Looking at growth this way, there is a significant difference between lightly/moderately infected trees and DMR class 6 (Table 3 adden).

Each of these tests suggests that there is no significant different in the rate of diameter growth among any DMR class from 0 to 3. This suggests that foresters will find very acceptable growth among thinned Douglas-fir in central Oregon given that leave trees are lightly infected (DMR class 2 or less) at the time of thinning. The real substance of this suggestion will be born out when we look at volumes in 1993.

H= 74.3279
H corrected = 74.4373

$\chi^2_6 = 12.592$ $(\alpha = 0.05)$

Degrees of freedom for chi square is 6

SE 1,2 = 15.6264	Q 1,2 = 0.618468
SE 1,3 = 17.2355	Q 1,3 = 0.179628
SE 1,4 = 15.4221	Q 1,4 = 0.538037
SE 1,5 = 19.172	Q 1,5 = 2.00807
SE 1,6 = 19.7516	✓Q 1,6 = 3.81476
SE 1,7 = 19.172	✓Q 1,7 = 7.29356
SE 2,3 = 19.239	Q 2,3 = 0.663258
SE 2,4 = 17.6328	Q 2,4 = 1.01867
SE 2,5 = 20.9915	Q 2,5 = 2.29442
SE 2,6 = 21.5222	✓Q 2,6 = 3.94998
SE 2,7 = 20.9915	✓Q 2,7 = 7.12177
SE 3,4 = 19.0734	Q 3,4 = 0.272719
SE 3,5 = 22.2153	Q 3,5 = 1.59362
SE 3,6 = 22.7174	✓Q 3,6 = 3.18046
SE 3,7 = 22.2153	✓Q 3,7 = 6.15504
SE 4,5 = 20.8398	Q 4,5 = 1.4492
SE 4,6 = 21.3742	✓Q 4,6 = 3.13695
SE 4,7 = 20.8398	✓Q 4,7 = 6.3117
SE 5,6 = 24.2195	Q 5,6 = 1.52146
SE 5,7 = 23.7491	✓Q 5,7 = 4.26682
SE 6,7 = 24.2195	Q 6,7 = 2.6625

Degrees of freedom for Q is 7

$Q_7 = 3.038$ $(\alpha = 0.05)$

1	0	2	3	4	5	6
a	a	a	a	ab	bc	c

Table 1, addendum.
Growth rate for trees of different infection class.

$X^2_{.05,6} = 12,592$

H= 23.6577
H corrected = 23.6585

Degrees of freedom for chi square is 6

SE 1,2 = 15.6377	Q 1,2 = 0.459702
SE 1,3 = 17.2479	Q 1,3 = 0.897521
SE 1,4 = 15.4331	Q 1,4 = 0.936275
SE 1,5 = 19.1858	Q 1,5 = 2.13935
SE 1,6 = 19.7658	Q 1,6 = 1.39586
SE 1,7 = 19.1858	- Q 1,7 = 3.9337
SE 2,3 = 19.2528	Q 2,3 = 0.430672
SE 2,4 = 17.6455	Q 2,4 = 1.22628
SE 2,5 = 21.0066	Q 2,5 = 1.61171
SE 2,6 = 21.5376	Q 2,6 = 0.947257
SE 2,7 = 21.0066	- Q 2,7 = 3.25053
SE 3,4 = 19.0871	Q 3,4 = 1.56807
SE 3,5 = 22.2313	Q 3,5 = 1.14995
SE 3,6 = 22.7337	Q 3,6 = 0.532689
SE 3,7 = 22.2313	Q 3,7 = 2.69848
SE 4,5 = 20.8548	Q 4,5 = 2.66101
SE 4,6 = 21.3896	Q 4,6 = 1.96544
SE 4,7 = 20.8548	- Q 4,7 = 4.31176
SE 5,6 = 24.2369	Q 5,6 = 0.555138
SE 5,7 = 23.7662	Q 5,7 = 1.44852
SE 6,7 = 24.2369	Q 6,7 = 1.97553

Degrees of freedom for Q is 7

$Q_{.05,7} = 3.038$

DMR

3 0 1 2 5 4 6

ab ab ab bc bc bc c

Table 2, addendum.
Response to environmental stress.

H= 47.1802
H corrected = 47.1804

$\chi^2_{.05,6} = 12.592$

Degrees of freedom for chi square is 6

SE 1,2 = 15.6379	Q 1,2 = 0.412042
SE 1,3 = 17.2481	Q 1,3 = 0.775591
SE 1,4 = 15.4334	Q 1,4 = 1.01503
SE 1,5 = 19.186	Q 1,5 = 0.0078518
SE 1,6 = 19.7661	Q 1,6 = 2.24502
SE 1,7 = 19.186	✓Q 1,7 = 5.91563
SE 2,3 = 19.2531	Q 2,3 = 0.360151
SE 2,4 = 17.6458	Q 2,4 = 1.25292
SE 2,5 = 21.0069	Q 2,5 = 0.29956
SE 2,6 = 21.5379	Q 2,6 = 2.3595
SE 2,7 = 21.0069	✓Q 2,7 = 5.70961
SE 3,4 = 19.0874	Q 3,4 = 1.52157
SE 3,5 = 22.2316	Q 3,5 = 0.594958
SE 3,6 = 22.7341	Q 3,6 = 2.54036
SE 3,7 = 22.2316	✓Q 3,7 = 5.70697
SE 4,5 = 20.8551	Q 4,5 = 0.758373
SE 4,6 = 21.3899	Q 4,6 = 1.34222
SE 4,7 = 20.8551	✓Q 4,7 = 4.69105
SE 5,6 = 24.2372	Q 5,6 = 1.83709
SE 5,7 = 23.7666	✓Q 5,7 = 4.78185
SE 6,7 = 24.2372	Q 6,7 = 2.8519

Degrees of freedom for Q is 7

$Q_{.05,7} = 3.038$

DMR	2	1	4	0	3	5	6
	a	a	a	a	a	ab	b

Table 3, addendum.
Performance ratio.